The Slow Control System of the Auger Fluorescence Detectors

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Abstract

The fluorescence detector (FD) of the Pierre Auger experiment [1] comprises 24 telescopes that will be situated in 4 remote buildings in the Pampa Amarilla. It is planned to run the fluorescence detectors in absence of operators on site. Therefore, the main task of the Slow Control System (SCS) is to ensure a secure remote operation of the FD system. The Slow Control System works autonomously and continuously monitors those parameters which may disturb a secure operation. Commands from the data-acquisition system or the remote operator are accepted only if they do not violate safety rules that depend on the actual experimental conditions (e.g. high-voltage, wind-speed, light, etc.). In case of malfunctions (power failure, communication breakdown, ...) the SCS performs an orderly shutdown and subsequent startup of the fluorescence detector system. The concept and the implementation of the Slow Control System are presented.

1. Introduction

The Auger experiment intends to measure Extended Air Showers (EAS) produced by highest-energy cosmic rays ($> 10^{18}$ eV). At these energies, the particles of the EAS stimulate N_2 molecules in the atmosphere to emit fluorescence light which is used to examine the longitudinal development of the shower. This fluorescence light will be measured by the fluorescence telescopes. In addition, 1600 water Čerenkov particle detectors will measure the lateral distribution of the particles in the EAS at ground level.

To ensure a secure operation, the SCS permanently has to monitor the current experimental conditions in each of the 4 FD buildings, especially those who endanger the telescopes (e.g. sunlight and wind). In addition, the SCS must be able to activate actuators (e.g. electric motors for shutters, failsafe curtains etc.) to protect the telescopes if necessary. A summary of control functions is

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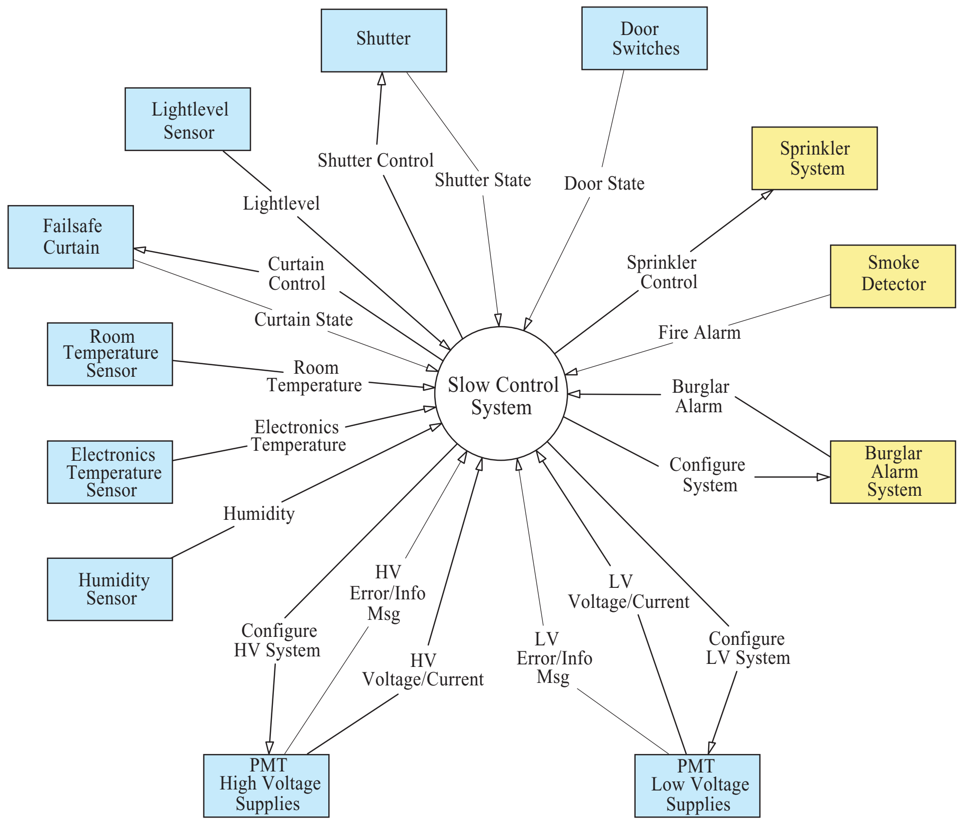

Fig. 1. Overview of the components that are monitored and controlled by the SCS

sketched in figure 1.

This necessity for reliable supervision and the desire for high flexibility and stability led to a SCS based on industrial components. The hard- and software implemented for the Auger FD telescopes will be presented in the following.

2. Hardware

2.1. The PROFIBUS*-system*

PROFIBUS-systems (PROcessing FIeld BUS) [2] are usually used in industrial environments where production processes are automated. Major advantages are its simplicity, stability and high flexibility. The used system is composed of several bus-terminals with specific functions (e.g. analog input, digital output, relay etc.). The connected terminals build up a modular bus-system which allows to address and control each terminal via PC. Through this concept, we were able to design a system that is adapted to the requirements but can also be modified, if requirements change.

2.2. The Field-PC

The so called *Field-PC* is the central instance of the SCS and runs the main control software under a *Windows-NT* operating system. It is designed for industrial application which require a high reliability [3]: it has no peripheral devices attached, is dust protected, needs no fans and is controlled by hardware watch-dogs. The specification for the mean time between failures (MTBF) is 8 years. Within our experience, gained in 2 years of operation, we observed no system crash.

3. Software

The main control software is implemented using a commercial product *4CONTROL* [4]. It contains both an integrated environment for developement of real time capable programable logic controller (PLC) applications for multi-target control and automation systems and the control itself. It provides the access to the *PROFIBUS* and an *OPC* (OLE for Process Control) server and client to communicate with other parts of the experiment. The OPC-server as well as an integrated *HTTP*-server allow e.g. remote operation via graphical user interfaces. The system supports programming in several languages: the Pascal like *ST* (Structured Text), the graphical language *SFC* (Sequential Function Chart), as well as *JAVA*.

4. Implementation

The implemented system for one of the fluorescence detector buildings is sketched in figure 2. Each building hosts six telescopes in so-called *bays*. In each bay the system operates the shutter doors. Protection of the telescope is achieved by monitoring the entrance doors and the light-level. In case of too much light a failsafe curtain is dropped in front of the telescope. The uninterruptible power supply (UPS) for each bay, data acquisition (DAQ) and the *Field-PC* are monitored. In case of a power cut, the UPS allows the SCS to put the telescopes, front-end electronics and DAQ computers into a safe state. Additional sensors watch the outside environment, such as wind, rain, temperature and light. In case of extreme conditions the SCS can take appropriate actions, e.g. closing of shutters in case of strong wind. The high and low voltages for the PMTs of the telescopes are monitored using the *4CONTROL* OPC client and a *CAEN* OPC server [5]. Other systems of the experiments, the DAQ and the graphical user interface in the main control room, interact with the SCS in the telescope buildings using the *4CONTROL* OPC server. They collect data and can request changes of the operation mode, unless these are in contradiction to SCS safety rules.

As a valuable tool for the understanding of the system and the development

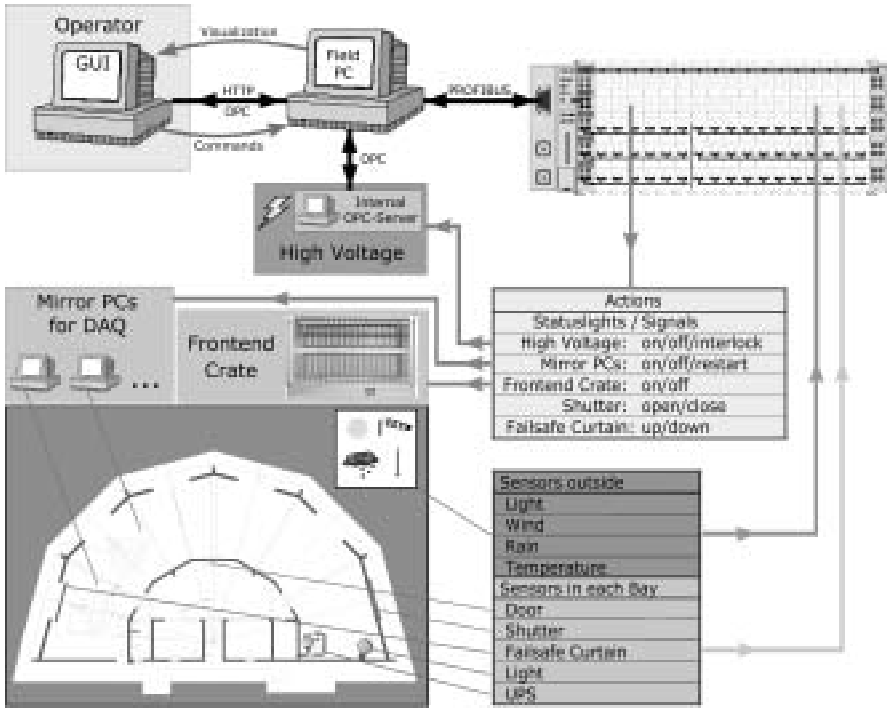

Fig. 2. Scheme of the SCS at the Auger experiment

of the control software under realistic conditions, we have built a test setup at Karlsruhe. The functionalities of sensors and actors of one building with one telescope have been modelled. The original hardware components are used, except for a few (large) parts, e.g. the shutter, which are simulated by smaller scale models. This setup allows to simulate realistic running conditions and to provoke various error conditions, such as cable breaks or power failures.

5. Status and Outlook

All different hardware components have been integrated and tested at experimental site. Presently, two buildings are equipped with SCS systems. Installation of remaining components is taking place. A first version of the operation software has been released and is continuously running. It is planned to allow the operation of 6 telescopes with full slow control by the end of summer 2003.

6. References

1. ICRC Auger overview talk, H. Blümer, these proceedings.
2. Profibus home page, `www.profibus.com`.
3. Softing, *4CONTROL Field PC, data-sheet*, `www.softing.de`.
4. Softing, *4CONTROL*, `www.softing.de`.
5. CAEN, *OPC server for CAEN power supplies*, `www.caen.it`.